process. For the reasons discussed below, Nakamoto and Chang et al. either alone or in combination do not disclose or suggest the claimed invention.

Nakamoto and Chang et al. either standing alone or in combination do not suggest the step of transferring a portion of an aligned carbon nanotube film from a first substrate to a conductive base as in the claimed invention. The passages of Nakamoto referred to in the Action disclose two separate and distinct processes for producing the carbon nanotube layer. In each process, the carbon nanotubes are formed directly on the electrically conductive layer. There is no suggestion of forming the aligned carbon nanotubes on a first substrate and then transferring a portion of the carbon nanotubes to a conductive substrate in a selected pattern to form the cold field emission cathode as claimed.

As discussed in the previous response, Chang et al. is relevant to the extent that a taping method is disclosed that randomly removes loosely bound carbon nanotubes from the electrically conductive substrate. Chang et al. does not use the taping method to form the field emission electrode. Furthermore, Chang et al. does not transfer aligned carbon nanotubes from one substrate onto an electrically conductive substrate as in the claimed invention. Therefore, the combination of Nakamoto and Chang et al. would still not result in the claimed process. The combination of Nakamoto and Chang et al. would result in a process that randomly removes loosely bound carbon nanotubes from the conductive layer. This is not the claimed invention. One skilled in the art would not be motivated by Chang et al. to modify the Nakamoto process to form aligned carbon nanotubes in a first step and thereafter transfer the carbon nanotubes to a conductive substrate as claimed.

Independent claims 1, 2 and 3 recite methods that are neither disclosed nor suggested in Nakamoto or Chang et al. The claims recite a first step of forming an aligned carbon nanotube film on a first basic substrate (not the final conductive substrate of the cold field emission cathode). A conductive binder is then patterned prior to receiving the carbon

nanotubes. After the conductive binder is patterned, the conductive binder is bonded to the surface of the aligned carbon nanotubes on the first basic substrate. The carbon nanotubes are transferred from the first basic substrate to the conductive binder according to the pattern formed on the conductive binder. The carbon nanotubes that are transferred to the conductive binder form the field emission cathode. Nakamoto and Chang et al. disclose forming the layer of the carbon nanotubes directly on the conductive layer and thereafter removing a portion of the carbon nanotubes to obtain the desired pattern. The aligned carbon nanotubes are not transferred to a conductive substrate in a selected pattern. This is not the claimed method regardless of how the carbon nanotubes of Nakamoto and Chang et al. are removed from the conductive layer.

Attached as Exhibit 1 are Figures 1-6 comparing the process of the cited art and the process of the claimed invention. Nakamoto discloses two methods for forming the carbon nanotube layer. The first method forms the carbon nanotube layer on the substrate 12 by applying the carbon nanotubes, by applying pressure or embedding in the substrate. Thus, Nakamoto deposits the carbon nanotubes directly on the conductive layer 12. The cathode interconnecting layer 26 is then deposited selectively on the conductive substrate 12 and a portion of the carbon nanotubes are removed from the conductive layer.

Referring to Figure 1 of Exhibit 1, the carbon nanotube layer is formed on the substrate 12. The conductive layer 28 or conductive material layer 34 are patterned on the substrate. Nakamoto does not disclose the length, density or thickness of the carbon nanotube layer. If an adhesive film A shown in Figure 2 of Chang et al. is applied as suggested in the Action, the adhesive will bond only to the loosely formed carbon nanotubes on the outer surface of the carbon nanotube layer, even if the adhesive film A is flexible. Thus, most of the carbon nanotube layer that is not contacted by the adhesive film remains on the conductive substrate 12 after removal of the adhesive film A as shown in Figure 3. Thus,

a pattern of the selective electron source is not formed by the adhesive layer A on the conductive layer 28 or the conductive material layer 34. The adhesive layer A does not form the field emission electrode. Figure 4 depicts a process where a substantial portion of the carbon nanotube layer is removed such that the number of carbon nanotubes on the resulting device is reduced. However, it is difficult to adhere and remove all carbon nanotubes which are not on the conductive layer 28 or the conductive material layer 34 since Nakamoto does not disclose the length, density and alignment of the carbon nanotubes. Applicants submit that the carbon nanotubes produced by the method of Nakamoto on the electron source in this manner would be inferior, lacking uniformity and being without alignment.

The claimed invention as depicted in Figures 5 and 6 of Exhibit 1 show a carbon nanotube film B with a uniform length, density and alignment that is initially formed on an adhesive film A. A conductive binder C in a selected pattern is formed on the electrode substrate D as shown in Figure 5. As the conductive binder C is contacted with the carbon nanotube layer B, the carbon nanotubes that contact the conductive binder C are transferred to the conductive binder C and the electrode substrate D with the remaining portions of the carbon nanotubes remaining on the adhesive film A shown in Figure 6. The carbon nanotubes are transferred to the conductive binder C when the adhesion of the conductive binder C is greater than the adhesion of the adhesive film A.

As discussed in the previous response, Nakamoto does not disclose aligned carbon nanotubes. However, the Action contends that the carbon nanotubes of Nakamoto are aligned, although provides no basis for this position. Nakamoto discloses forming the carbon nanotube layer by forming a dispersion and then applying the dispersion to the substrate 12. As specifically disclosed in column 5, lines 2-7, "the carbon nanotube 16 normally exists like fallen trees overlapping each other on the support substrate 12". Nakamoto further states that "for the sake of simplicity, the carbon nanotubes rise nearly vertically <u>in the following</u>

drawings" (emphasis added). Thus, Nakamoto specifically states that the drawings show the vertical nanotubes for purposes of illustration and simplicity, but recognizes that the carbon nanotubes are, in fact, not aligned or vertical. Furthermore, Nakamoto does not form an aligned carbon nanotube layer on a substrate and thereafter contacting the nanotube layer with a pattern conductive adhesive layer to transfer the aligned carbon nanotubes from the first substrate to the conductive layer.

Chang et al. does not provide the deficiencies of Nakamoto such that the combination of Nakamoto and Chang et al. do not render the claimed process steps obvious to one of ordinary skill in the art. Chang et al. is directed to a method of forming a nanotube layer by screen printing using a paste that contains nanotubes. Chang et al. uses an adhesive tape as a method of mapping nanotubes buried in the paste and removing nanotubes that are poorly adhered to the paste or substrate. The Abstract of Chang et al. specifically states that the adhesive film removes "those badly bonding CNT portions". Thus, Chang et al. does not transfer aligned carbon nanotubes from one substrate to an electrically conductive substrate in a specified pattern to form the field emission emitter. Chang et al. does not control the density or height of the napped nanotubes because of the random distribution of the nanotubes.

Chang et al. is directed to a screen printing of a paste containing carbon nanotubes. The carbon nanotube paste contains an organic binder, resins, and silver powder in addition to the carbon nanotubes. The screen printing of the carbon nanotube paste has several disadvantages. Since the nanoscale materials tend to agglomerate in the paste, it is difficult to mix the paste to uniformly distribute the carbon nanotubes. The non-uniform mixture of the carbon nanotubes and the film forming materials when applied to the electrode display an image that is not uniform, since the density of the carbon nanotubes included in each electron

source in the electrode is not constant. This results in unevenness on the surface of the electrode.

In addition, the other components are applied to the edge and surface of the carbon nanotubes during the formation of the paste. Since the edge and the surfaces of the carbon nanotubes form an electron emitting site, the coating interferes with the electron emission by these other components. It is difficult to remove the film forming components on the molecular or elemental level from the edges and surfaces of the carbon nanotubes by the ablation of the adhesive tape as in Chang et al. The purpose of the adhesive tape of Chang et al. is to form an napped surface of the carbon nanotubes and to remove poorly bonded carbon nanotubes from the substrate.

Chang et al. forms the carbon nanotube layer directly on the conductive substrate and applies the adhesive tape to remove unwanted carbon nanotubes. Chang et al. does not suggest taping to transfer aligned carbon nanotubes from a first basic substrate onto a conductive substrate in a pattern arrangement. Therefore, applying the taping method of Chang et al. to the method of Nakamoto would do nothing more than remove loose carbon nanotubes.

It is advantageous to use lower voltage and uniform strength electron emission to operate a display apparatus using a cold field emission cathode. Thus, the shape of the carbon nanotube electron source of many of the carbon nanotubes used for the field emission cathode is preferably aligned to the electrode and has a uniform height. It is also preferable that the carbon nanotubes be insulated from each other. The maximum electrode emission is generated in the vertical direction by the totality of the carbon nanotube electron sources.

The uniform electron emissions are generated in the direction of a surface if the surface is uniform and contains carbon nanotubes of uniform height. The voltage withdrawing electron in the electron emission is lowered as the edge of the carbon nanotube

becomes closer to the anode. Thus, if the height of the electron source of each unit is constant, the distance between the edge of the carbon nanotube remains constant when the anode is positioned close to the surface of the electron source. This results in a lower voltage at the same electron emission.

The process of the claimed invention produces carbon nanotubes with uniform length, alignment and density. The electrode is patterned and then the carbon nanotubes are transferred to the electrode as shown in Figures 5 and 6 of Exhibit 1. Therefore, the carbon nanotubes on the resulting electrode has a uniform length, alignment and density.

In the emitter of the present invention, the electrons are emitted at the edge of the carbon nanotubes through its conductive body after passing through the conductive layer from the electrode. Thus, the applied voltage is utilized effectively since there is substantially no resistance.

In contrast, in the emitter produced according to Nakamoto, the carbon nanotubes receiving the electrons by contacting the electrode is often different from the carbon nanotube emitting electron on the surface of the deposition. There is a disadvantage where the applied voltage is not effectively utilized because of the high resistance by passing through many contacts points of the carbon nanotubes. As noted above, it is possible to emit electrons directly from the electrode which receives the electron by contacting the electrode where a small number of carbon nanotubes are provided. However, in this arrangement, the number of emission sites are extremely small so that a high current density is not obtained even if the same voltage is applied. The emission becomes rough since the length, density and alignment of each tube is not uniform.

In view of the above comments, neither Nakamoto or Chang et al. disclose the claimed process steps. Furthermore, Chang et al. provides no motivation or incentive to one of ordinary skill in the art to modify Nakamoto in the manner according to the claimed

invention. Therefore, independent claims 1, 2 and 3 are not obvious over the combination of Nakamoto and Chang et al. The dependent claims are also allowable for depending from an allowable independent claim.

Accordingly, reconsideration and allowance are requested.

Respectfully submitted,

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Figure 1

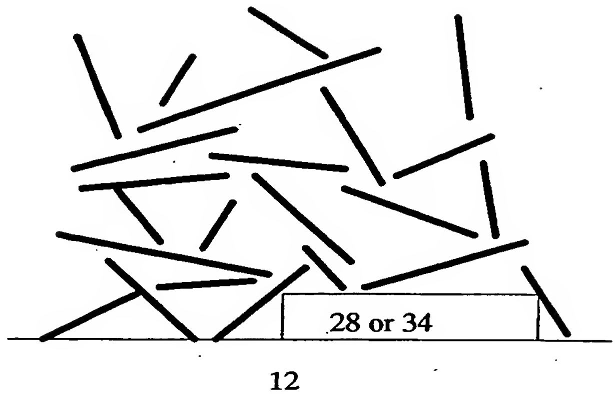

Figure 2

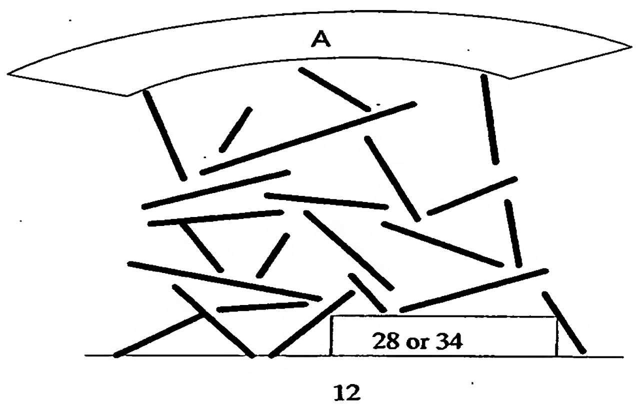

Figure 3

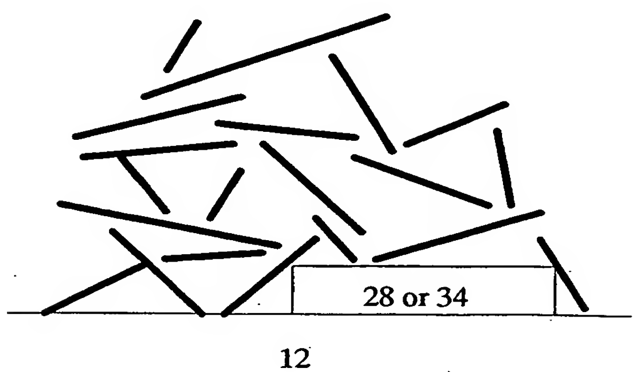

Figure 4

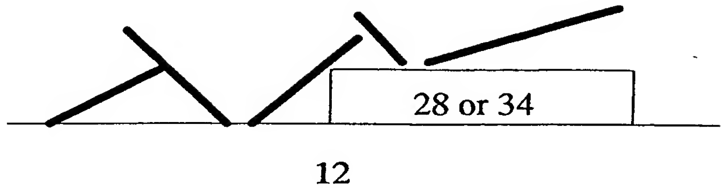

Figure 5

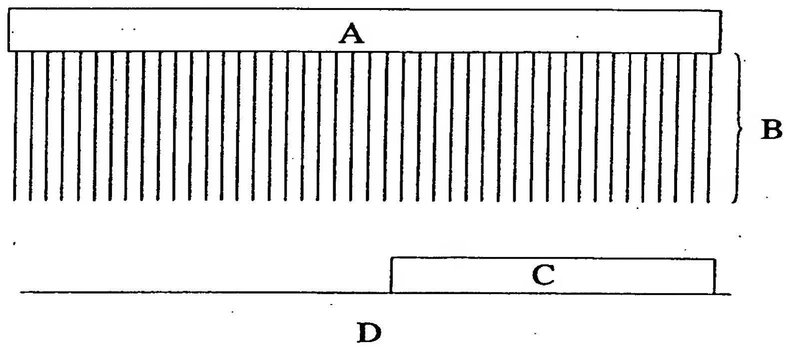

Figure 6